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## **MEMS based sun sensor**

*Carl Christian Liebe  
Sohrab Mobasser*

Future nano spacecraft and nano rovers need to carry sun sensors to determine the pointing direction towards the sun. Conventional sun sensors are typically too large compared to the size of a nano spacecraft or nano rover. Therefore, research into MEMS (Micro Electro Mechanical System) based sun sensors has been initiated.

Two categories of conventional sun sensors exist - digital and analog types. The digital sun sensors illuminate a geometric pattern on the detector plane. The presence or absence of light in these well-defined areas defines a digital signal that can be translated into the sun angle. Analog sun sensors outputs analog currents, that can be related to the sun angle.

A new generation of sun sensors is emerging. These sun sensors typically utilize an imaging chip as detector plane with a mask placed in front of them. The sun sensor determines the sun angles based on an image of fringes or centroids on the detector plane.

At the Jet Propulsion Laboratory, there is currently an ongoing research task to miniaturize sun sensor technology utilizing MEMS technology. In the initial stages of the project, a large number of masks with different patterns has been manufactured in MEMS technology and mounted 500 microns from an imaging detector array. Both one and two axis sunsensor patterns on the masks has been manufactured. The imaging detector array has been operated as both digital and analog detector. Simulations have been performed to simulate the electromagnetic image in the near field behind the mask on the focal plane. The MEMS masks were manufactured out of a 500-micron thick silicon wafer.

This paper will describe the mask designs, the simulations and the experiments. The algorithms used to determine the sun angle will also be discussed.

Future directions for this task will be discussed. Possibilities include manufacturing a custom designed focal plane array, facilitating a passive MEMS analog sun sensor. Another possibility is to utilize e.g. an APS chip as detector plane array with automatically centroid calculation included in the focal plane electronics. The power supply for this might be an additional  $1\text{cm}^2$  solar cell next to the MEMS mask.

The final product of this research task will be to demonstrate a sun sensor, the size of a couple of coins stacked on top of each other.